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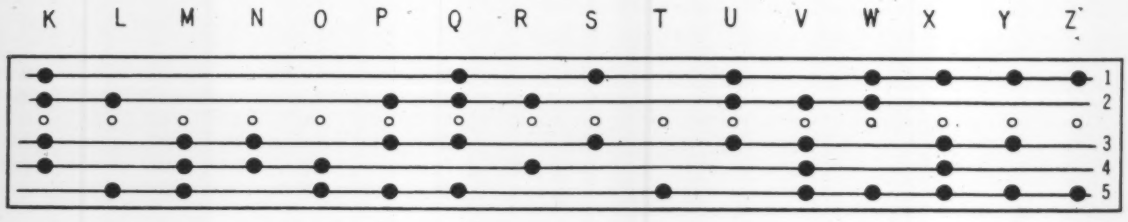
Elements of Construction and Reliability in Machine Languages

by Gordon M. Nonnemacher

►The construction of machine codes is familiar to most of us in one degree or another. And, although there are many codes, we notice a common element in them, which is binary construction. This binary nature manifests itself in the form of punched holes, magnetic spots and spots of ink. Each of these holes or spots is called a bit, also referred to as a mark when present in a channel of the code, and a space when absent.

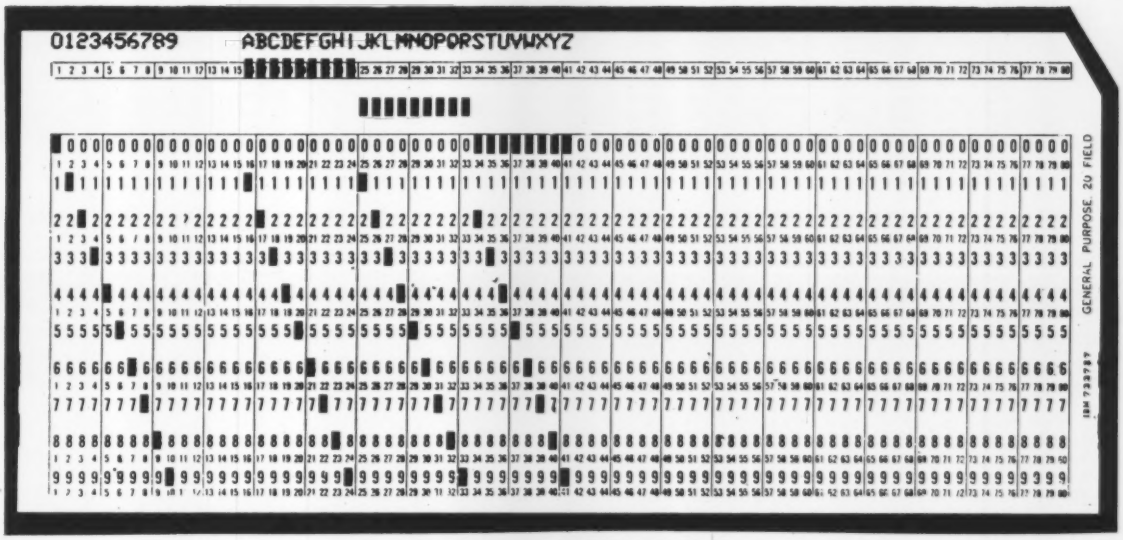
The punched holes, or their absence is sensed by mechanical pins which set up corresponding electrical conditions within a machine; marks on magnetic tape, when moved past a reading device, induce a current which serves as input to a machine, and inked spots, as well as punched holes may be read photo-electrically for impulsing machine circuits.

In the permanent storage mediums of punched cards, paper tape, magnetic tape, etc., characters and numbers appear serially, as they do in the written word. The individual bits that represent each character generally appear perpendicular to the



PARALLEL CODE CHANNELS

Figure 1



IBM PUNCHED CARD CODE

Figure 2

sequential character flow. (Fig. 1) Thus a series of characters is represented by a group of parallel rows or channels of information. One character is thus represented by a binary bit, that is, a "yes" or a "no" condition in *each* of the channels.

The number of possible character combinations available from a code is determined by taking the number two (representing "yes" or "no"), and elevating it to a power equivalent to the number of information channels in the code. Thus, in a five channel code the number of possible combinations is two to the fifth power, or thirty two. A six channel code will have 64, etc.

When there is a restriction on the number of punches (or marks) allowed to represent a character, the number of possible combinations is reduced, and may be determined by using the formula for combinations, which is:

$$C = \frac{n}{r \; n - r}$$

where c is the number of possible combinations, n is the number of things (channels in this case) and r is the grouping which they take. For instance, if we take a five channel code, and specify that each character *must* have three punches out of the five possible, the total number of combinations is ten:

$$C = \frac{1.2.3.4.5.}{(1.2.3).(1.2)} = \frac{120}{12} = 10$$

The IBM punched card code is developed on a twelve channel basis. It can be seen from Fig. 2 that the zero channel occurs three quarters of an inch from the top edge of the card, and channels 1 through 9 appear successively below to the bottom of the card. The eleventh channel appears just above the zero channel, and the twelfth just above the eleventh. Num-

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continued

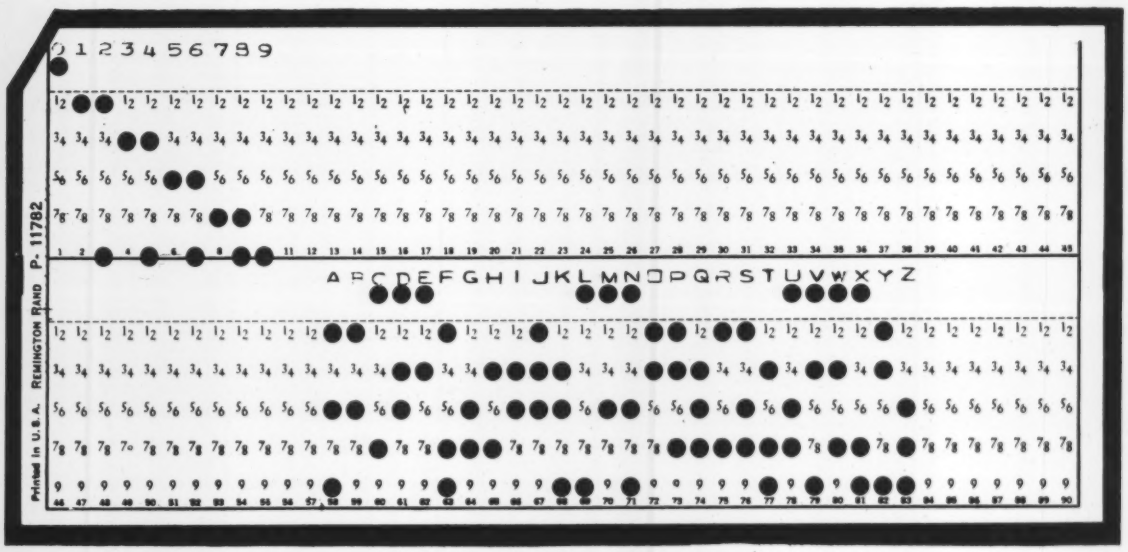
bers 0 to 9 are represented by a single punch in the appropriate channel, i.e., 0 to 9. Each letter in the alphabet is represented by two punches. "A" through "I" having a common punch in channel 12, with the second punch in one of the channels 1 through 9. "J" through "R" having a common punch channel 11, with the second punch in one of the channels 1 through 9, and "S" through "Z" having their common punch in the zero channel, and the second punch in one channel 2 through 9.

The Remington Rand card code is represented in six channels. These channels are numbered 0, 1/2, 3/4, 5/6, 7/8 and 9. (Fig. 3.) Numerals are represented by either one or two punches; e.g., the number one is represented by one punch only in the 1/2 channel the number two is represented by two punches, one in the 1/2 channel, one in the 9 channel. The alphabet is developed by use of two or three punches per character in any of the six channels.

The so-called common language five channel code has, as previously mentioned, 32 possible code combinations. After adapting five of these codes for space, carriage return, line feed, and functional shifts called FIGURES & LETTERS, the entire series less these five becomes available again for reassignment in a second, or upper case shift. The upper case being designated FIGURES, and the lower case LETTERS. Thus 27 perforation combinations appear in the "LETTERS" shift, which are used to denote the alphabet, and the same 27 combinations are again used in the "FIGURES" shift for numerals, and punctuation marks. (Fig. 4.) The 27th combination which is all blank, (no perforations) is generally not assigned in either shift.

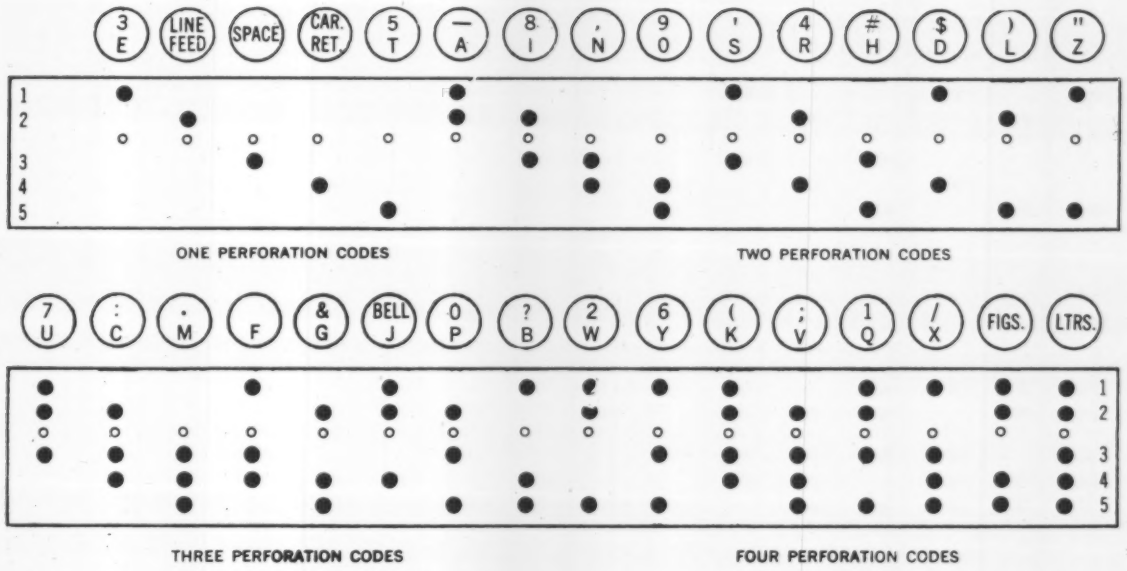
When a sixth channel is added the number of possible code combinations becomes 64. Several approaches to a code are possible here; first, we could start from scratch and assign the sixty-four code combinations to any numbers and letters and functions we desire, thus confusing the issue with a new code.

Secondly, the standard five channel code construction can be used, and by add-



REMINGTON RAND PUNCHED CARD CODE

Figure 3



FIVE CHANNEL "COMMON LANGUAGE" CODE

Figure 4

ing the sixth channel eliminate the need for FIGURES, and LETTERS SHIFTS. As an illustration, in the standard 5 channel code the letter "E" is represented by a punched hole in the first channel of the tape in the LETTERS shift; the same punch in the FIGURES shift represents the number three. In this six channel code the "E" would still be represented by the same punch; the three represented by the same punch but with the addition of one punch in the sixth channel. Thus, codes in the LETTERS shift are unchanged from their five channel structure, the five channel codes in the FIGURES shift have one punch added in the sixth channel.

If a shift character were used here the 64 combinations, less the functional codes would be available again for a total of 118, which could be used for capital and small letters and additional symbols.

A third alternative with six channels is to use the standard five channel code, with the sixth channel serving the function of a vertical parity check.

The seven unit codes use six information channels with the seventh channel for vertical parity checking. The seven unit codes vary in construction because of the internal circuitry of individual computing devices. For example, the Univac code uses an odd parity check, while the IBM 705 uses an even parity check. The IBM 705 uses a straight binary coded decimal, while the Univac uses an excess three binary coded decimal.

In a binary coded decimal the first four information channels are labeled 1, 2, 4, and 8. Any number from 0 to 9 then may be represented in true binary notation. The number two, for example, being represented by a mark in the second channel, which corresponds to the familiar 0010 binary notation representing two. A three

continued

is represented by a punch in the first channel and a punch in the second channel, corresponding then, to the 0011 binary notation for a three.

Binary notation of course can be used for a number of any size, however, since the number of channels in a code is limited it becomes more convenient to use the binary notation only through the number nine. Numbers greater than nine appear in decimal form such as a binary noted two and a binary noted three, for the number twenty-three. This is how it gets the name of binary coded decimal. (Fig. 5)

	2	3
1	0	X
2	X	X
4	0	0
8	0	0

The number twenty three as a binary coded decimal: 0010,0011

Figure 5

In the excess three binary coded decimal each digit is raised to the binary notation for a character three steps above it. Thus, a three is shown as a binary six, a four as a binary seven, etc. Both of the seven channel codes use the seventh channel for parity checking and the first four channels for the numeral identification. The fifth and sixth channels are used to denote alphabetical and other symbols as an expansion on the codes for the numerals.

In one eight channel code used by several business machines, the first four channels are for numerals, in binary coded decimal fashion, the fifth channel is for an odd parity check, the sixth and seventh channels expand for the alphabet, and the eighth channel is used only to indicate carriage return. (Fig. 6.)

Another eight channel code uses the basic five channel construction for the letters of the alphabet, with the sixth channel expanding for numerals, punctuation marks, etc. The seventh and eighth channels are both used for odd parity checking, the seventh channel showing parity in channels

TAPE TO CARD PUNCH	8 CHANNEL TAPE CODES								FLEXOWRITER AUTOMATIC WRITING MACHINE
	EL	X	O	CH	8	4	2	1	
0 (ZERO)			O						0 (ZERO)
1								1	1
2							2		2
3				CH			2	1	3
4						4			4
5				CH		4		1	5
6				CH		4	2		6
7						4	2	1	7
8					8				8
9				CH	8			1	9
A		X	O					1	A
B		X	O				2		B
C		X	O	CH			2	1	C
D		X	O			4			D
E		X	O	CH		4		1	E
F		X	O	CH		4	2		F
G		X	O			4	2	1	G
H		X	O		8				H
I		X	O	CH	8			1	I
J		X		CH				1	J
K		X		CH			2		K
L		X					2	1	L
M		X		CH		4			M
N		X				4		1	N
O		X				4	2		O
P		X		CH		4	2	1	P
Q		X		CH	8				Q
R		X			8			1	R
S			O	CH			2		S
T			O				2	1	T
U			O	CH		4			U
V			O			4		1	V
W			O			4	2		W
X			O	CH		4	2	1	X
Y			O	CH	8				Y
Z			O		8			1	Z
SPACE				CH					SPACE
—		X							—
/			O	CH				1	/
#					8		2	1	STOP
$		X		CH	8		2		$
,			O	CH	8		2	1	,
.		X	O		8		2	1	.
@				CH	8	4			NP CODE
%			O		8	4			PRINT—RESTR
*		X			8	4			PUNCH 1 ON
¬		X	O	CH	8	4			UPPER CASE
&		X	O	CH					&
SKIP			O	CH	8	4	2		TAB
END CARD 1					8	4	2		
END CARD 2			O		8	4	2	1	PUNCH OFF
COR. TAB				CH	8	4	2	1	
ERROR		X			8	4	2	1	ERROR
PI 1				CH	8		2		PI 1 (2, 8, SP)
PI 2		X			8		2		PI 2 (2, 8, -)
PI 3			O		8		2		PI 3 (2, 8, 0)
PI 4			O	CH	8	4		1	PI 4 (5, Z)
PI 5		X	O		8	4		1	PI 5 (N, Z)
PI 6		X		CH	8	4		1	PI 6 (9, N)
PI 7					8	4		1	PI 7 (1, 4, 8)
SP-1		X	O	CH	8		2		LOWER CASE
SP-2		X	O		8	4	2		PUNCH 2 ON
CR		X		CH	8	4	2		SPECIAL CODE
TAPE FEED		X	O	CH	8	4	2	1	TAPE FEED
END LINE	EL								CAR. RET.

EIGHT CHANNEL FLEXOWRITER CODE

Figure 6

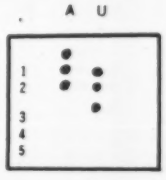
1, 3 and 5, and the eighth channel showing parity in channels 2, 4, and 6.

Redundancy, which means excess or super-abundant, is the basis of error detection methods. And, as we never get anything for nothing, there is a certain cost for redundancy. Written language, of course, is highly redundant. The individual spelling of most words and phrases provides readily recognizable combinations of letters and words that are easily deciphered often when misspelled or lacking a letter or two. It is not so easy, however, to decipher a string of numbers, and an omission or wrong number will completely change the meaning of the group.

Since most data is made of groups of characters and numbers, which will be acted upon by a processing machine exactly as presented, it becomes essential that the data be protected in some way from errors and omissions. On a purely local basis, the possibility of a punching or reading error in a punched tape, or punched card machine is extremely remote and certainly not worth the expense of improvement. This high degree of reliability is due in part to the high quality of the mechanical components of most data processing machines and in part to the fact that many of these machines operate on a parallel wire basis. Thus, *each channel* in the code between, let us say, a reader and a punch block or a keyboard and a punch block is on its own individual circuit. The redundancy in this most satisfactory arrangement is in wiring and components, and its cost is relatively small when the distance between the corresponding units is not extended beyond distances of a few feet.

In computers the circuitry is generally parallel, but in view of the thousands of electronic components involved and the amounts of data handled it becomes relatively inexpensive and very worthwhile to provide parity checking.

Vertical parity checking is accomplished by a redundant channel in the code, whose marks indicate either the odd or even nature of the vertical sum of the information channels. For example, let us look at a vertical odd parity check applied to the five channel code. The letter "A" is represented by two marks, one in channel one and one in channel two. Two marks is an even number, so we add one mark in the check channel to make it odd. (Fig. 7.) The letter "U" is represented by three marks, an odd number, in channels one, two, and three, but since this is already an odd number there will be no mark in the check channel. Thus if in the course of processing, a contact fails to close, or a tube fails or a reader or punch fails, or for some other reason one of the bits representing a character is dropped, or if an extra bit is added, the parity of the character will not check and the error will be detected.



VERTICAL ODD PARITY CHECK

Figure 7

It is equally possible to check parity horizontally, that is, determine whether the marks in each channel are odd or even up to a certain point, then insert one "character" which represents the odd or even nature of each of the channels in the code, up to that point. This method can be made less redundant than a vertical parity check, because the checking channel is eliminated, and a character which appears at predetermined intervals is substituted. Of course, the longer the interval of the check character the less the redundancy. In data trans-

continued

	X	O	R_1	R	7	4	2	1
A	X	X		X				X
B	X	X					X	
C	X	X					X	X
D	X	X		X		X		
E	X	X				X		X
F	X	X				X	X	
G	X	X		X	X			
H	X	X			X			X
I	X	X			X		X	
J	X		X	X				X
K	X		X	X			X	
L	X		X				X	X
M	X		X	X		X		
N	X		X			X		X
O	X		X			X	X	
P	X		X	X	X			

	X	O	R_1	R	7	4	2	1
Q	X		X		X			X
R	X		X		X		X	
S		X	X	X			X	
T		X	X				X	X
U		X	X	X		X		
V		X	X			X		X
W		X	X			X	X	
X		X	X	X	X			
Y		X	X		X			X
Z		X	X		X		X	

	X	O	R_1	R	7	4	2	1
0		X	X		X	X		
1	X	X	X					X
2	X	X	X				X	
3			X	X			X	X
4	X	X	X			X		
5			X	X		X		X
6			X	X		X	X	
7	X	X	X		X			
8			X	X	X			X
9			X	X	X		X	
Space			X	X	X	X		
Restart					X	X	X	X
① EOC Start	X				X	X	X	

	X	O	R_1	R	7	4	2	1
3-8				X	X		X	X
12-3-8			X		X		X	X
11-3-8	X				X		X	X
0-3-8		X			X		X	X
4-8				X	X	X		X
12-4-8			X		X	X		X
11-4-8	X				X	X		X
0-4-8		X			X	X		X
② EOT			X		X	X	X	
TEL				X	X	X	X	

① EOC IS END OF CARD START ② EOT IS END OF TRANSMISSION

IBM TRANSCEIVER CODE

Figure 8

mission redundancy is paid for with line time.

It may be well to mention the failing of odd or even parity checking, which is the compensating error. This type of error is one in which there are two errors preceding a parity mark, thus cancelling its effect. A compensating error is much less likely to occur in a vertical parity check than in a horizontal check, because of its higher redundancy. When serialized transmission is involved; that is, when the bits comprising a character are sent one after the other a seven unit code with vertical parity check will be only 90% effective with random error generation. This means that although the parity checking unit is operating at 100% efficiency, some of the characters which pass the parity check are still in error. This efficiency rate is due to the presence of compensating errors.

A highly redundant but reliable check is the four out of eight check utilized by the IBM Data Transceiver. (Fig. 8.) This is an eight channel code in which each character is represented by four marking and four spacing conditions, giving a total of 70 possible character combinations. This code is checked by determining that each character is composed of four marking and four spacing pulses. Should a shift occur within a character (gain of one pulse, loss of another) which preserves the four mark, four space requirement there still remains a reasonable chance the error will be detected. The logic of this lies in the fact that all of the 70 possible combinations are not assigned, thus the possibility for the shifted character to fall into this group and be detected as an unoperable code.

The data transceiver reads the standard IBM card code, but it sends its line signals in the four out of eight code. At the receiving end, a reversal causes standard cards to be punched.

Prototype units for a five channel self-checking code with high efficiency and low redundancy are currently being evaluated for telegraph use. This check utilizes a binary nonsense total. For checking purposes the channels in the code are labelled 1, 2, 4, 8 and 16. It is possible, with a binary counter, to obtain a sum of the marks for each character as it is transmitted. For example, the letter "I" is represented by marks in the second and third channels

(binary notations 2 and 4). In accordance with their notation the sum of the marks for the letter "I" is 6; i.e., a two and a four. (Fig. 9.) This amount is added to the previous sum of all characters, until at a discrete interval the entire total is transmitted in the form of several redundant characters. The receiving device also performs this summing operation during transmission and at the end of each series its total will be compared to that received in the redundant check total. Any discrepancy between the totals indicates an error. Unlike the vertical parity check, this method of checking, as well as the horizontal parity check, does not isolate an individual errored character; instead, it isolates a block which contains an error. The block length is dependent on the spacing of the summary characters, which may be arbitrarily chosen. A short block limits the errored area but is more redundant than when the spacing is relatively long.

"I"

1	0
2	X
4	X
8	0
16	0

Figure 9

The personnel aspect of reliable data processing is not entirely within the scope of a discussion on machine languages, however its proximity to the subject allows at least a cursory treatment. Every day experience points up the fact that people make more errors than the machines they operate.

Quality control tests have demonstrated that experienced typists make fewer errors in preparing plain language than in groups of coded letters and numbers. Other factors influencing error rates include, operator training, experience and attitude toward the work, the speed which must be sustained, lighting conditions, and the hour of the day.

Corrective measures include proofreading or key punch verification, both by a person other than the preparing operator, careful operator selection and training, and adoption of the principles of mechanization of repetitive data so that operators have less data to actually prepare.

There is an unanswered question which deserves consideration in any data handling system. This question is, what is an acceptable rate of undetected errors? An undetected error is one which is not caught in the routine data processing. Most errors will eventually be detected somewhere along the line, when the books fail to balance, or a control total is wrong, etc., but the emphasis on self-checking codes is to eliminate time and cost in rectifying these errors by catching them at their point of occurrence. However, no error checking arrangement is 100% foolproof, and any system is going to have some errors.

An average error checking arrangement may catch 90% of the errors which occur, while a highly complex system may come very close to perfection. The problem here is which costs the most, a few undetected errors, or the complex equipment to give almost errorless data processing.

The answer depends on many factors. Among these are the direct costs of tracking down and correcting every error, the potential financial loss from over or under shipping, overpaying, etc., the volume of data handled, and the nature of the data handled; i.e., whether it is action or record data.

No general solution to such a question is possible, and each user must evaluate the situation himself. **s/p/a**

Grouping systems and procedures with organizational planning is a logical move

Organization Planning and Systems

Address delivered to SPA Toronto Chapter, December, 1957.

► Organization planners require a philosophy in order to ensure that organization changes are not simply a matter of expediency or the result of short-range considerations. That philosophy must be based on the nature of the job of the manager. Systems and Procedures people, more than anyone else, are the ones who provide the assistance that managers need to carry out the work which is unique to the job of managing.

It appears that if you want to find out what a manager does for a living—don't for Heaven's sake, ask one or you will end up quite confused.

The president of a large U. S. corporation was asked what he did in order to manage the operations of the company. After some thought, he suggested that he managed through approvals—he approved employee salaries; he approved appropriation requests above $1,000.00; he approved vacations and leaves of absence; he approved the vendors which were to be used by the company, and so on. He managed by approving the recommendations of others.

In another company, the general sales manager was asked "What are you doing when you are managing the sales activities of this company?" In his opinion, there was no doubt about what sales management meant. "I go out and sell more of our product than anyone else. To be a manager you have got to show your salesmen that you know more about selling than any of them". His concept of management, you see, was management by example.

Recently a foreman was followed about the floor of a large manufacturing plant. He was hard to catch because he was driving a fork truck, but eventually he stopped, and after the normal introductions, he was asked, "Do you manage this department?" The answer was "Yes".

"Are you managing it now?" . . . "Yes".

Mr. Allan is Organization Planning Analyst in the office of the executive vice-president, Ford Motor Co. of Canada, Toronto.

G. G. Allan

& Procedures

"Why do you manage this department by driving around in this fork truck?"

"Well, the way I figure it—managing means knowing what all your people are doing and checking up on them to make sure they are on the job and not getting us into trouble . . . Hell, on the fork truck I can do a little material handling and manage at the same time."

His concept of management was very close to the duties of a policeman; he kept an "eye on things" quite literally.

No, we are not going to get very far by asking others. And it just may be that many problems confronting Systems and Procedures departments and Organization Planning departments today are a result of the varying awareness of managers as to the essential and universal characteristics of their job.

A manager has nine separate responsibilities which he and he alone must carry out. They are unique to the job of a Manager. He cannot delegate them to others. He should organize to delegate as much as possible of the non-managerial work.

First: He establishes, publishes and interprets objectives. This is one of his principal duties. Much of his time should be spent in making sure that his subordinates know at all times what is expected of them. Do the objectives tie in with company objectives? They often don't and this is perhaps the greatest single reason for abnormal administrative expense.

The best test of the essentiality of a particular activity is relating its objective to overall company objectives. The quickest way to lower earnings is to entertain activities within your company which are not essential to either short, or long-range profits.

Clearly defined objectives are the starting point for your work, as well as mine.

Second: A manager establishes, publishes and interprets policies. A definition of a policy is this—"a course of action to be consistently followed under stated conditions, without reference to higher authority". In other words, it is a means through which managers can relieve themselves of saying "Yes" or "No" to a question which is constantly recurring. It should be second nature to managers, when they make a decision, to ask themselves if this is a recurring situation or not. If it is determined that under the same conditions the decision will always be the same, then commit it to writing and publish it. Policy writing is often a fine way of keeping people out of your office!!!

Your interest in policy making is clear—you must establish and publish the series of steps that must be carried out to fully implement the policy. Systems people must re-write the policy in specific terms so that its intent will be carried out.

Third: Managers plan budgets. The word "Plan" is used because it is the budget that compels management to plan their operations for the future. It is the budget that enables management to appraise the financial effect of future plans. It is the budget that acts as a yardstick against which per-

continued

formance is measured. Budgets, it is said, should squeeze people into doing the right thing.

The Systems and Procedures departments have never had a bigger challenge relative to cost reduction, than today. Every time I get on a subway train at 5 o'clock I cannot help the feeling that comes over me that all those people are pure overhead and half of them would be unnecessary if we reversed the existing trend toward elaborate systems, controls and general red tape. Undoubtedly you have read the recent National Industrial Conference Board report relative to the effect of automation on the labour force structure. It seems that our efforts in improving methods in the factory through work simplification and its resulting mechanization of material handling, has reduced the direct and indirect labour force in the U. S.

Listen to this: "The Conference Board study, after a survey of 130 companies, found that:

1. The proportion of workers engaged in direct production labour has declined during the past three years.
2. The proportion of workers in the factory indirect labour force, such as maintenance, production control and industrial security personnel, also has dipped since 1954 relative to total employment.
3. These shifts in the labour force are accompanied by proportionate increases in non-factory employment, such as head office, clerical and sales personnel."

We should not, however, lose our perspective on this matter of relative factory and office efficiency. Some of the change in the ratio of factory to office employees is due to better—and more elaborate—administrative controls. The most obvious examples are preventive maintenance and warranty analysis and control programs—both of which reduce the number of factory personnel but require more clerical help—at an overall saving to the Company. There are many more examples of this type.

We must also recognize that the *consumer* controls the number of articles modern and efficient factory equipment will produce. No such rigorous control exists relative to the number of reports and analyses that moder nand efficient office equipment will produce. It is too often true that management increases its demands for information just because the new office machine can produce it and not because the increased information makes for better control.

Fourth: Managers plan organization. Organization planning is the logical grouping of activities, delineation of responsibility and the establishment of relationships for the purpose of enabling people to work most effectively together in accomplishing the objectives of the company. And while we are at it, I would like to try and clear up a few of the fuzzy definitions of words that are so often used by organization and systems people.

"Responsibility" is work, mental or physical, which is assigned to a position.

"Authority" is the powers or rights which are required to perform work.

"Accountability" is the obligation of an individual to render an account to the principal to whom he reports, of the fulfillment of his responsibility according to certain specified standards.

It should be stressed that responsibility cannot be delegated without commensurate authority. The delegation of responsibility without an accompanying and commensurate authority to fulfill it is, in effect, no delegation at all. It is not possible to charge an individual with responsibility and at the same time deprive him of authority to enforce his decisions in connection with the fulfillment of the responsibility. Lacking authority to compel compliance with his plans and instructions, he has actually been relieved of his responsibility and the accountability for it.

Similarly, when responsibility is delegated to an individual, it must be made clear that he accepts the obligation to answer to his superior for his success or failure in the execution of his duties.

Managers at every level, when delegating responsibility, should realize that they are at the same time granting commensurate authority. They should also recognize their obligation to provide standards of performance and means of measuring the quality and quantity of the work in relation to these standards.

My, how we need to learn that this is a major duty of every manager. Setting up an organization department does not cancel this responsibility one whit from every manager in the company. It is my personal view that if we spent less time looking for organization experts and organization theories, and each manager planned his organization to carry out the work which must be done to reach his objectives, we would not have so many conflicting theories and expensive organizations.

Here again we seem to have mutual interests. I submit to you that no changes in administrative and selling staff should take place unless organization planning can review the revised or enlarged responsibilities to ensure that they are essential. At the same time, it is so often true that a review by the Systems and Procedures group of the circumstances resulting in a request for more people, can lead to a methods improvement or a revised procedure or system that would make an increase in staff unnecessary. I don't know of a better signal for methods improvement or procedure review, than a request to increase the administrative staff. This must be done before the organization is changed. It is much more difficult after the new people come.

I would be remiss, while discussing our mutual interests relative to organization planning, if I did not requote two famous organization laws:

Parkinson's Law states: "With the proper allocation of responsibility it is possible to organize so that seven men are required to perform a job which was previously carried out by two".

And let us not forget Norman's Law: "With the proper division, sub-division and corresponding cross referencing of the work, it is possible to reduce a normally simple situation to a state where it requires an expert."

Fifth: Responsibility of a manager is to select, motivate and develop people. Again we sometimes make the mistake of assuming that this is up to a staff man—this time the Industrial Relations man. I often wonder about some of the management and personnel development programs on which industry spends so much time and money. Many of them amount to moving people around from one department to another and giving them the so-called "Big Picture" or "the overall company viewpoint". It seems to me that people develop when their performance is reviewed periodically—not principally from the point of view of discussing weaknesses, but through a mutual discussion of the factors which resulted in previous objectives not being attained—followed by the establishment of objectives for the future.

Our schools and universities develop students through frequent tests and examinations, followed by a review of their mistakes. At the same time, new work is assigned which will be the background material for the next examination. *This system works!!* We should use it more in industry for developing our people.

The proper organization structure with wide spans of managerial responsibility can *force* managers to delegate *non*-managerial work to their subordinates and so aid in their development.

Systems and Procedures people have so many parts to play in helping managers to manage that they should become good

continued

managers themselves. The managerial activity which is not normally *directly* related to the work of the Systems and Procedures department is the job of selecting, motivating and developing people. This should, therefore, be *your* interest in order that you can fully qualify as a person skilled in all of the facets of good management.

Sixth: Managerial responsibility is to establish programs—managers determine what work is to be done, when it is to be done, and who is to do it.

Seventh: The function of co-ordination.

The best definition of a co-ordinator that I know is this: "A co-ordinator is someone who attempts to separate two people who should be working together." I wonder if this function of management is not over-exaggerated. I also wonder if industry doesn't possess a lot of people called "Managers" whose *only* function is co-ordination.

One of the principal benefits of a procedure is to provide automatic co-ordination. I wonder if Management (and I mean all managers everywhere in the company) does not expect help in the establishment of procedures which otherwise would require constant co-ordination. Let us go even further than that. I believe *top* management would say to the Systems and Procedures Department something like this: "Managers cost money and we don't want any more of them than is absolutely necessary. We suspect that we have managers who do nothing but co-ordinate matters in which a published procedure would provide automatic co-ordination."

A Systems and Procedures Manual can pay for itself many times over by eliminating the need for the co-ordinators which we call managers.

Many companies use committees as agencies of co-ordination. I wonder if some committees could not be disbanded by a well thought out procedure.

Eighth: Responsibility that belongs to the job of the manager is the responsibility of control. That is—setting standards, appraising performance to these standards and taking the appropriate corrective action when required. Effective control depends on a system of effective reports. It is you, gentlemen, who can make a great contribution to all company management through the design of a reporting system which will tell each manager just what he needs to know and nothing more.

There are few significant changes in organization which also do not require changes in reports. Might I suggest, at this point, two essential parts of the design of a proper reporting system.

The first is this—start at the top, with your president, and work down through the organization.

Secondly—request every manager from top to bottom to sit down with the people to whom they have delegated responsibility and work out the information, *and its frequency*, that the manager requires to be assured that the work delegated is being carried in line with previously established objectives.

Sound organization rests on a sound reporting system. The organization planner and the Systems and Procedures man have a lot of co-operating to do in this all-important matter of control.

Last: Managerial responsibility is to make decisions on all matters not specifically delegated. It is the responsibility involving withheld authority. Most of such authorities which are withheld are those which require co-ordination and thus must be reserved for the only level in which co-ordination can be exercised. However, there are some authorities which are withheld during a period in which a subordinate is in training. A word of warning, though—personnel development depends on granting enough latitude for making mistakes and many good training opportunities are missed by managers holding back authority too long or to too great a degree.

We have been talking about the work that is unique to the manager. We were led to this in our attempts to determine a basis for the close relationship which you and I know exists in the work of Systems and Procedures people and Organization Planning people.

We found that a manager establishes, interprets and publishes objectives, policies and programs; he plans organization and budgets; he selects, motivates and develops people; he co-ordinates, he controls and he makes decisions relative to authorities which cannot, or should not be delegated. Systems and Procedures, and Organization Planning people, must work closely together in the exercise of each managerial function. Often our viewpoints were different, but our motives were the same—effective company management and organization.

In the process of this comparison, we resolved that the work of companies should be organized so that managers can concentrate on the essential responsibilities of their positions and keep non-managerial functions in proper perspective. By so doing, the so-called span of control (now recommended to be 4 or 5) can be changed to what I will call a span of management which can be more than doubled. Loose, expensive organizations with a built-in lack of communication, are often the result of the two familiar remarks: "He has 6 people reporting to him now—you can't give him any more" or "It should not report to him—why bother him with such details".

My answer to the first is that managers, concentrating on managerial work, can easily handle from 10 to 20 people. My answer to the second is "I don't think objectives, policies, personnel motivation and other managerial activities can be called 'details'."

We also said that organization planning involved a logical grouping of activities. What further evidence do we need? What could be more logical than grouping Systems and Procedures with Organization Planning? And as we have seen, our work relates to the job of all managers wherever they may be. As such it would be appropriate for the Systems and Organization department to be accountable to the Chief Executive Officer.

Increased productivity in our factories has been gained through the combined efforts of the work study man, the work simplification and methods man, the machine operator and material handler, the industrial engineer, the machine tool manufacturer, and a host of others. They throw a challenge to you in Systems and Procedures and to we in Organization Planning to combine our efforts to reverse the proportionate decrease in productivity in other areas of the company.

We have already mentioned the ways in which this can be done—clearly defined policies and procedures, a properly designed and integrated system of reports, the control of forms (and, by the way, it is far easier to establish a retention period when the form is designed than years later), work simplification, and the design and use of modern office equipment and machinery.

Let me leave you with two thoughts:—

1. Systems and Procedures and Organization Planning have much in common. Our work is focussed on the responsibilities that are unique to the manager, whatever his level or wherever he may be.

2. In carrying out our work we cannot afford to neglect that body of knowledge which is possessed by those affected by our procedures or organization plans. We can obtain it through proper clearance of our proposals with the field—but better yet, we can obtain it by using that old system of the British Admiralty—reducing the amount of field clearance time, by always having a number of people in our departments who are just "back from the sea". **s/p/a**

How can a man best assess and appraise his abilities

Planning for Success in Industry

by John L. Handy

Mr. Handy is president of Handy Associates, Inc., management Consultants in New York and San Francisco.

► What is the problem of the individual who is undertaking a career in business or professional work, and what is it as he advances in years and experience?

At the risk of oversimplification, I may say that it is, first, objective analysis of himself and his progress with the assistance of others who are in a clearer position to help him in such objective analysis; and, second, sound planning for success. Such a plan should establish long-range and intermediate objectives. Every few years it should be re-examined and re-assessed in view of the man's development, and changing conditions.

How does one undertake to construct a plan?

In my exectuive counselling I have thirty-five questions which I ask in order to clarify and orient a man's thinking, and to give me a basis of fact and opinion from which to develop the advice which I am later to give him. The two questions which practically no one has been able to answer readily are, curiously enough, "What are you trying to do?", and, "What do you want out of life?" I have asked these questions of executives well into their forties making between $40-50,000 a year; and it is evident that very few men have clearly in mind just what they *are* trying to do and what *are* their long range objectives.

The extremes lie between the man who told me, "I am going along in a mood of quiet desperation, doing the best I can for one more day, hoping that from week

to week and from year to year, I will be guided by the obvious; and, on the other hand, the individual who to date has progressed comfortably with no planning on his own part and without encountering any acute difficulty.

Long-Range Plans

At the risk of again oversimplifying a complex problem, I may say that my experience has shown that most men want out of life the satisfaction that they have done the best which could be expected of them with the tools that were given them. On the same basis, it is apparent that what most men are trying to do is to progress in their narrow or wider field of activity or development.

Based upon the above premises, how can a man best assess and appraise his abilities and ambitions, how can he establish long-range plans, and short-range objectives? And how often should he re-examine this plan, and how can he determine its value and success, and modify it in view of his progress and changing conditions?

The career plans of many, and later changes in these plans, are frequently affected by the remnant of the Puritan tradition in us which leads us to believe that what we don't like is probably good for us, and what we can't do we should attempt. There are no more unstable guides to success than these two urges; for one should seek the line of least resistance, namely to undertake that for which he is best qualified, and that activity in which he finds the maximum of stimulus and enjoyment.

Therefore, let a man determine as early as possible, preferably before he is thirty-six, the field of endeavor to which he is by nature best suited, and which brings him the maximum of stimulus and pleasure. A man of eighty, chairman of the board and chief executive officer of a successful company, who radiates the joy of life and still is an enthusiastic although electrically-conveyed golfer, told me, "I go to my office as I go to the golf course". A man who goes to work in the morning with the sentiment, "Off to the salt mines", and leaves at 5 o'clock as though he were escaping from jail must not be surprised if he does not generate more interest in his employer than the job has generated in him.

Of course, the first preparation for a career is education, but most of those who hear this talk or read it later will have graduated from college and whatever professional school they expect to attend, and, although their education may be later supplemented by graduate work, this graduate work will probably be a continuation of the education already received. A fortunate man is he, who in his teens, found his interest in life in a field which was practical for him to follow; and prepared himself for progress in this field in his college education. However, it is a grave mistake for a man to feel that, having made one mistake in selecting the wrong field of activity, and prepared himself for it by education, he

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should remain in that field in spite of the fact that it has become clear to him that his greatest abilities and major interest lie in a field distinct from that for which he has been educated. Any sound educational training will be of benefit to a man in any phase of industry, and it is absurd for a man to cling doggedly to his uneasy course on the assumption that, like the postage stamp, his usefulness consists in his ability to stick to one thing until he gets there.

Age Brackets

In planning for the future, a man's business life falls, or may be divided, into the following age brackets. First, 22 to 28 years old; in this period a man should be feeling himself out, and savoring his taste for work. It is a blessing if he does not meet the right girl until he is 28, because he should hold himself free to move from one company or industry to another, and to any area of the country, where his best opportunity for experience and growth lies. It is in some cases a good thing if he takes three 2-year jobs within these 6 years so that, within the industry, he can have a broader background of experience.

At 28, unless he made such a bad early choice of jobs that he is bewildered, he should have determined the area for which he is best suited and in which he is the happiest. He should also have some idea of the part of the country in which he would prefer to live, although one rule for advancement is mobility; in other words, he must not turn down jobs which present to him the next logical step in advancement simply because he has put his roots down too early in any one community. He should try to avoid during these years finding himself in a spot where he must consider any other factor in the selection of a job than the prospect that it will develop him, and presents a logical advancement in his career as planned. He should never take a job that does not qualify under these considerations simply because he can make more money in such a job, or get some flimsy advance in title.

In the years from 32 to 36, he should be mature enough to outline his objectives and determine his probable ceiling, and take steps to raise this ceiling progressively as he goes along.

Unfortunately, almost every man *has* a ceiling which is not apparent at the lower levels of responsibility because the qualities, or lack of qualities, which will block him at the higher levels of responsibility are not apparent at the lower levels, or are not those which prevent him from satisfactorily performing his duties at these lower levels. A man swings up to his ceiling very easily and without much check, and, if we projected on a chart his progress, it would appear that he would go to the very top. Unfortunately, in many instances, he does not develop progressively as might have been anticipated, and when he hits the ceiling he commences going sidewise. This is a frustrating and to an extent an almost shocking experience; and it is seldom apparent to the man that he has run out of gas. He prefers to believe, naturally enough, that his check is due to circumstances beyond his control, and the misappraisal of his effectiveness on the part of his superiors. This frequently results in the period of two year jobs which attacks many men at the age of 36 to 38, and leaves them wiser, but shaken, at 44 to 46. It is an attempt to escape from reality, and results from faulty self-analysis and appraisal, and an unwillingness to accept the fact that everyone, with a very few exceptions, has a limit from which he progresses slowly, and usually with arduous effort.

The happy man is he who appraised his own ceiling as much lower than it really was, with the result that, when he reached his ceiling, he is happy, proud, and satisfied. Hence, during the years 32 to 36, and perhaps a little older, a man should try to

set reasonable objectives for himself and prepare thoughtfully and cheerfully for the training which will enable him to obtain these objectives. For instance, a man who is an ace staff man, perhaps a chief industrial engineer or a successful member of a consulting firm, should realize that the abilities which make for success in staff work, frequently hinder a man in executive work. Also, some of the qualifications for a successful executive vary distinctly from those for a successful staff man. We have helped *FORTUNE* and other magazines write articles describing the qualifications of the executive, but in general, the successful executive knows how to get things done through the efforts of others who, by the very nature of their experience, must know their jobs better than the executive will ever know them themselves. The best executive is intelligent and lazy, whereas the staff man is intelligent and industrious; and this last qualification of the staff man frequently prevents him from happily delegating work to others if, for no other reason, than that he prefers to do the job himself with the help of subordinates, but without delegating any particular authority to the people working for him.

At 38 a man should have a reasonably clear idea of what he can do best and what he enjoys most, and the next four years should be spent in development in this area, although not necessarily with the same company.

In the period from 38 to 42, the man should really consolidate his position. He should recognize that men are attacked by periodic restlessness, and this seems to become most acute within these years. Many of the most foolish mistakes, and damaging blotches on a career, are made by faulty decisions which are principally induced by restlessness in this period.

A man came to me some years ago, age 44, with a sad but familiar story. He had a few years earlier struck a temporary plateau in his advancement in one of the large companies, and had been tempted to take a general management position in a small, shaky company, which paid him a comparatively large salary, and granted him large stock options. The owners of the business were trying to bolster the credit and prestige of the company by having a man from a large, successful company in the top position. They could not afford an experienced general manager from such a company, and such a man would have, undoubtedly, been too sophisticated to take the job. Just as a buyer needs 1,000 eyes and the seller but one, a man who takes a job with a company such as this should have 1,000 eyes to search out the reason why he should leave it alone.

At the end of three years, it was obvious to him and the owners as well that he was not experienced enough for such a position, and that the problems were close to insoluble anyway. His pride was such that he did not like to go down in level of responsibility so he took another job of more or less the same character which lasted two years; and, at age 44, he would have been very happy to get the old job back in the big company that he deserted at age 38.

Also, in the period 38 to 42, a man should further realize that at the lower levels of responsibility, a man progresses through energy and intelligence. From the period we are discussing onward, his progress will be the result of judgment, and his ability to direct wisely and effectively the efforts of others.

Wisdom Pays Off

Unfortunately, brains do not imply judgment. Brilliance is impressive in the young, but it is wisdom which eventually pays off; and we have before us constantly the accumulation of brilliant subordinates supporting the far less brilliant, but wiser superior, who culls their ideas before put-

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ting them to use. Brilliant idea-men do not always show sound judgment. A company president told one such man, "George, out of 10 ideas which you present to me, 5 would ruin any company, 4 of them are completely impractical under the existing conditions, but from the tenth we make a lot of money. Keep on putting them before me because straining them out is my job."

Some years ago we were called upon by a large chemical company to secure a director of research, salary no object; and in the course of this search I saw most of the top research executives in the country, with salaries ranging from $50,000 to $90,000 per year. The two qualifications that stood out in all of these men were not brilliance or concentration, but first administrative ability and the ability to get along with people, and second, reasoning ability and judgment.

During these years from 36 to 40 or 42 a man should appraise himself for the qualities which make for success, which are (1) drive, (2) responsibility, (3) the ability to think, (4) the ability to get along with people and (5) the ability to communicate. A man can make a brilliant, if limited, success without all five of these qualities, but he cannot reach a top executive position in industry without them. Further qualities of the successful executive are curiosity, or the desire to explore alternate possibilities; and an uneasy feeling that things within his area of responsibility could be handled more effectively and successfully.

To summarize, I might say that in the progress to success, a man may be a boy at 36, but he must be a man at 42. The mistakes in judgment such as taking the wrong job, will not be held particularly against him before he is 36, because it will be scored up as a mistake of youth; but a mistake at 40 or 42 in one's own affairs, may well give pause to his superiors in considering him for a wider range of responsibility, or selecting him for further growth and development within the executive group; for it may well be considered that a man who lacks judgment in his own affairs at 40 or 42 may not be the best possible executive to whom to delegate important decisions in the company's affairs. It is a poor rule that has no exceptions, and this is a rule with many exceptions. The Chinese have a proverb: "In the affairs of others, even fools are wise; in one's own affairs, even the sages err."

Broadening Interests

In the period from 36 all the way through to 50, a man should be broadening his interests outside of work. He must be a good companion, fun to work with, pleasant for outside contacts, such as bankers and lawyers, with whom he must discuss the problems of business, if he attains the level of general management. A good many men lose momentum in the period between 40 and 50, because no matter how effective they may be in their particular jobs, they are dull fellows in other respects. Many executives take cultural extension courses in some university or otherwise develop non-business interests.

The value of entertaining in promoting business success is variously appraised, but, in general, the entertaining that builds firm and valuable business relationships comes from the mind and the spirit; that is, what comes out of the mouth, not what goes in it. As a man advances in the executive hierarchy, if he as an individual is not entertaining, his attempts to entertain are futile.

In the period from 40 to 50 a man should be laying careful plans for the building of his estate. Unhappily, many men awaken to the fact that there is no golden door which will open at age 55. They find themselves approaching that age with very little tangible results to show for their efforts, although they have been otherwise success-

ful. Commencing at age 40, he should review the executive incentive compensation plans, the retirement plans, the stock purchase plans, of his company, and see whether they are soundly devised to give him proper tax shelter, and the opportunity to build an estate. The period from 45 to 65 are the years of realization. He should determine to continue to do his job better; and be resigned to the fact that rapid progress from his present level of responsibility may well be attended by risks out of all proportion to the prospect of gain. He should concentrate on building an estate, not only for his own use after retirement, but for the benefit of his descendants, and to some extent perhaps for his community.

A man age 40 to 45 frequently feels that, if he can get his children educated and launched in the world and reach the age of 65 with a comfortable pension in view, his goal will be attained. In his latter 50's he realizes that a pension gives him no hedge against inflation, it leaves nothing for his children and grandchildren; and that he will be a vigorous man in all probability at age 65, and may like to buy into some business to keep active and maintain his income. I have encountered no frustration greater than that of the able man who has had ample income but who has nothing to show for it but a home, car, and a few dollars in the bank when he reaches sixty; and you might be surprised to know how many are in this condition.

If there is any purpose in life, it seems to be in broad growth and development. The full life is one that leads onward and outward. Tennyson makes the aging Ulysses say: "I am a part of all that I have met, yet all experience is an arch where through gleams that untravelled world whose margin fades forever and forever as I move." Growth depends on the eager eye, the listening ear, the thoughtful mind and the warm heart. May we all continue to enjoy growth and its benefits. **s/p/a**

Worth Reading

"Quick Copy Cuts Our Filing Costs," R. Roman Wilson, *Modern Office Procedures,* January, 1958.
A central filing unit analyzed its work and found that most time was spent writing charge-out slips and refiling returned material. A copying machine was installed and now a copy is made and given out in place of the original document. Thus the original is returned to the files immediately and no charge out slip is made.

"The Impact Of Computers On Multiple Line Operations," John B. DeNault, *The Controller,* March, 1958.
Summary of the Experience of Farmer's Insurance Group with an IBM 705. Although personnel has been reduced by 65 in departments directly related to the computer no overall savings are claimed. Savings from salaries are balanced out by yearly rental ($450,000) and programming and installation costs ($200,000). However, the following benefits are noted: 1, increasing number of policies serviced per employee; 2. toning up of entire paperwork system—especially adherence to deadlines; 3. additional data available for management.

"Procedure Manuals Program The Work," Edward Mezner, *NAA Bulletin,* January, 1958.
Discusses benefits of procedure manuals, how to start preparation of a manual, physical features and writing style. Oriented to small company operation. Suggests the following are costs of not having procedure manuals: 1. high priced personnel may do low-cost work; 2. high training costs for

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new employees; 3. high employee turnover; 4. difficulty in alternating employees; 5. duplication of work; 6. omission of necessary procedures; 7. inconsistency in procedures; 8. buck passing. Includes a sample of cook-book writing style compared to "procedures".

"Applied Sampling Doubles Inventory Accuracy, Halves Cost," Allan L. Rudell, *NAA Bulletin*, October, 1957.
Describes Minneapolis Honeywell's sampling system used for annual inventory. Inventory was segregated into high-value and low-value lots. All the high-value lots were counted but only about 10% of the low-value lots. Of a total inventory of 40,000 items 4200 were counted. The result gave an inventory value within eight-tenths of one percent of the value established by a 100% physical count. Time required for annual inventory was reduced from 5 days to 2.

"Your Office Needs New Ideas—Here's How You Can Get Them," Joseph H. Jackson, *The Office*, December, 1957.
Discusses blocks to creative thinking, Characteristics of creative persons and ways to stimulate new ideas. Common blocks are: 1. evaluating ideas in terms of what others think; 2. inertia; 3. domination by supervisors; 4. infrequent changes in routines. Studies have indicated that original thinking is related to a sensitivity to defects, fluency with words and ideas, and flexibility in thinking. Alex Osborn's checklist from Applied Imagination is cited as a technique to help generate new approaches.

"EDP At The Franklin Life Insurance Company," Albert C. Vanselow, *Office Executive*, February, 1958.
Detailed account of how a Univac is used 3 shifts a day for 5 days each week. Major routines are: 1. Billing; 2. Writing past due commissions; 3. Processing paid premiums; 4. Calculating first year and renewal commissions. About 300,000 policies are involved.

by Prof. William Sattler

"Semantic Noise"

► In the *Mathematical Theory of Communication*, by Claude E. Shannon and Warren Weaver, the engineering aspects of message sending are identified as "accuracy of transference of various types of signals from sender to receiver." The word "noise" is introduced to explain unwanted additions, such as static and sound distortion, that make the received signal vary from the signal transmitted.

But in addition to "noise" in the mechanical sense, it is possible to speak of "semantic noise" when the sender chooses words that distort reality. What has been said concerning the seven language habits that create communication crises can be thought of as "semantic noise" produced by the message sender. And likewise, when the receiver is motivated to distort the speaker's message, we may also speak of mental or "semantic noise."

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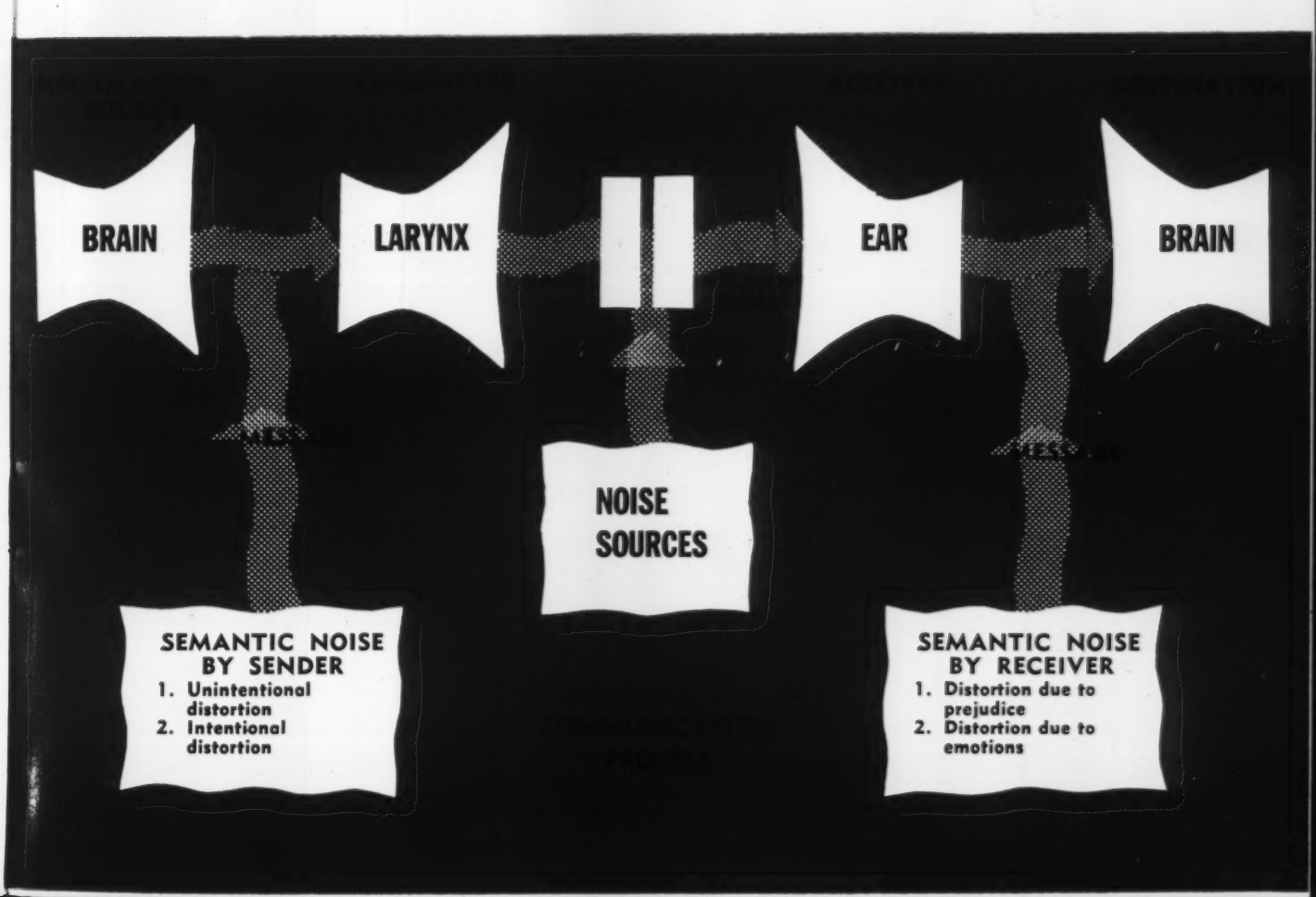
Final part of a three part article which discusses the importance of selecting the proper language in communication

Applied to Speakers and Listeners

This diagram, adapted from Shannon and Weaver, gives us a visual picture of the communication process, including human or semantic distortion.

The poet-philosopher Heine made this perceptive remark: "The arrow belongs not to the archer once it has left the bow; the word no longer belongs to the speaker when it has once passed his lips." We find that language affects thinking and behavior and, in some cases, the listener is fully victimized by word magic. He is not likely to be able to say, "What does the speaker really mean?" nor "Let us figure out some new words to see whether we can agree." It takes uncommon good sense for the lis-



continued

tener to translate the distortion created by the speaker into an objective depiction of what the speaker should have stated. In still other cases when the listener has a predisposed attitude of opposition, he is deliberately seeking to discover distortions that may be committed by the speaker. While the message sender may protest and say that his words have been misinterpreted, the listener victimized by "semantic noise" tends merely to repeat back the damaging words originally uttered.

Korzybski General Semantics and Ourselves

In 1933 Alfred Korzybski used the term "general semantics" in his *Science and Sanity,* and tried to distinguish his view of semantics from the word studies of linguists, lexicographers and logicians. "First order facts," he said, "are more important than definitions and verbiage." This, perhaps obvious but neglected point of view, suggests that Korzybski was interested in the study of language in a somewhat different way from most persons who analyze word meanings. His system is a living semantics that affects us in our daily communication in the community, in business, or in the home. To be sure, occasional critics argue that there is nothing new in what Korzybski presents except the name semantics, for roots of his ideas can at times be noted in dozens of sources ranging as far back in history as the dialogues of Plato. What he did however was to focus attention on language and communication by a detailed and systematic study that has in turn prompted others to explain semantics in books designed for the layman. In large part the language habits explained in this article represent some of the theories and techniques given by Korzybski in his scheme for "retraining nervous systems" and thus improving human communication.

Semantics is sometimes as important to our behavior as the external conditions represented in our environment. On one occasion a section of employees were labeled "the dreamers" in a casual conversation. Presumably "thought" preceded this label-giving, but the word itself wrought more havoc than one might expect because the men in this section thereafter were treated *as if they were* dreamers. And conflict was the consequence in a situation in which good human relations was a requisite for effective departmental performance. Recall, for example as well, that the Nazis likened human society to the white ant colonies of Africa—having established this comparison, they treated human beings in this fashion. If we speak of others as lackeys who should be uncritical recipients of orders, we will tend to treat them with indifference and disrespect. If we refer to man as a machine, we may expect him to behave like a machine. Thinking, in short, does affect our language choices, but language also conditions our thinking and behavior. **s/p/a**

"EDP In Inventory Control," Raymond D. Builter, *Office Executive,* January, 1958.
Detailed illustrated description of Columbia Record's order-billing and inventory control system. The company employs about 2500 people and has 8000 items in stock.

"How To Plan Your Mail Room For Action," *Modern Office Procedures,* January, 1958.
Detailed description of the volume mailing process followed by a letter service agency. The example used is a 3 piece mailing to 12,000 persons. Emphasis is placed on the sequence in which sorting and stuffing is done, mechanization, and quality controls.

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Excerpt from seminar on "Systems and Procedures--General," presented at the 1957 International Systems Meeting in Los Angeles

Systems Surveying and Analysis

by James A. Kerr

► Of prime importance in performing any systems task is the collecting of information. Such information is necessary even to determine the exact problem before any attempt is made to improve results. Moreover, a certain amount of information is necessary to determine if a problem *does* exist, since the reporting of results may be less efficient than the operations covered. Such information gathering and its organization for application to the problem at hand constitutes the "survey." By a normal and frequent extension of this definition to include the trials and errors of the synthesis and installation of improvements, the entire systems task ofttimes is categorized as a "survey."

Surveys will vary in accordance with the task in hand, the techniques available to the analyst, standard practices within the systems group, and the preferences of the department being studied. Step-by-step outlines may be set-up. A desk-by-desk study may be followed. Flow charts, simo-motion charts, retention schedules, job manuals, and other study devices may be prepared or reviewed. Probably the only two things that any two surveys will have in common are a specific objective and a plan of operation.

Some recommended survey patterns, adapted from standard sources, are as follows:

1. The Statistical Method (1)

- A. Collect material.
- B. Classify, tabulate and correlate the material.
- C. Summarize.
- D. Interpret critically.

This is the generic pattern of the logician for all analysis.

2. The Job Methods Training Approach

- A. Break down the job.
- B. Question every detail. (why? what? where? when? who? how?)
- C. Develop the new method:

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1) "Essentials of Scientific Methods," A. Wolf, The Macmillan Company, New York, 1937.

continued

1) Eliminate.
2) Combine.
3) Rearrange.
4) Simplify.
5) Work out your ideas with others.
6) Write up your proposed new methods.

D. Apply the new method.

This is, in essence, the "JMT" program espoused by the War Manpower Commission during World War II to get the utmost return from available manpower.

3. The Forms Analyst's Program (2)

A. Collect and organize:
1) Collect and classify all forms.
2) Inventory all office machines and their features.
3) Inventory all filing equipment.
4) Chart and classify all tasks performed.

B. Analyze your system.
C. Eliminate every unnecessary operation.
D. Simplify every essential operation.
E. Mechanize every operation where such mechanization can be economically justified.

4. The Overall Viewpoint (3)

A. Plan the study.
B. Obtain accurate systems information.
C. Analyze:
1) Delegation of functional authority.
2) Layout.
3) Physical operations.
4) Forms.
5) Equipment.

D. Determine the best solution.
E. Prepare a written report.
F. Sell your proposal.
G. Prepare written procedures.
H. Install the system.
I. Follow-up periodically.

5. The Accountant's Approach (4)

A. Sell your objectives.
B. Chart the organization.
C. Chart the layout.
D. List all reports (End Products)
E. Determine the tasks performed.
F. Chart work flow and forms flow.
G. Determine work loads and time requirements.
H. Study the reports for modification.
I. Determine possible economies from methods changes.
J. Prepare a report.
K. Draft forms.
L. Write instructions.
M. Assist in installation.

Each of these approaches, attacking the problem from a different viewpoint, recognizes the elements of collection of data, analysis, synthesis, selling and installation. Although all of these elements may be performed as a systems department function any one or more of the five elements may be entrusted to other hands, with the systems function performed in an advisory, consulting or liaison role. Certainly, by standardization of operations or by carefully tailored survey forms, the bulk of data collection and some of the analysis can be entrusted to the operating department or to embryonic systems personnel.

A common, and certainly justifiable, approach to the not-too-heavily-mechanized operation is the collection, analysis and classification of forms. Since the forms are normally the vehicle by which the operations are performed, and are alike the raw material, work-in-progress and end-product of the processing, control of operations consists largely of controlling forms. Where justified, either specific forms or specific operational steps can be set up for the collection of time and volume data for comparison with possible operational improvements.

The information gathered in a survey must be as accurate as possible within the

2) "Integrated Cost Control in the Office," Frank M. Knox Company, Inc., New York, 1953.
3) "Systems Analysis for Effective Administration," Norman N. Barish, Funk & Wagnalls Company, New York, 1951.
4) "Accounting Systems: Procedures and Methods," Cecil Merle Gillespie, Prentice-Hall, Inc., New York, 1951.

economic limitations of the study. Generally, such information is no more reliable than its source. Interrogation must be coupled with observation. Two sources may be considered more reliable than one. Where testing is feasible, tests may be taken to verify or substantiate information submitted.

It is well, too, to realize that sometimes a supervisor or department head, who is supposed to know what is going on in his own department or section, is not always well informed. Although he may assume that the work is being performed as outlined in verbal or written instructions, such may not be the case. Oftentimes he is too far removed from the work level to have information upon which you can rely. There is a difference between what is being done and what somebody says is being done.

Of considerable importance in contacts outside the systems department is the personality of the systems analyst. The analyst who finds himself disliked will have a difficult time procuring unbiased information or opinions, and will be an utter failure as a sales representative for the improved procedure.

However, a thorough analysis of information collected will oftimes disclose the inadequacies or inaccuracies of such information. Where such misinformation is minor, a quick patch-up can be made with authenticated data. Should the information be of major consequence a more comprehensive or better informed restudy can be made to secure more reliable data.

Analysis

Analysis may be defined as "critical interpretation." It is a breaking down into components or elements so that these elements may be individually studied and valued.

Systems analysis is primarily a breaking down or separating of an operation into its components for more minute study and classification. Whereas a need may be established for a certain report, the design of the form to which it is transcribed, the extent of the information include therein, the number of copies required, the method of transcription, the frequency of preparation, and numerous other details can frequently be scrutinized profitably.

Consideration in such analyses must be given to the costs of capital invested; to the expenses of designing, printing and controlling forms; and to the costs of space; in addition to the cost of labor. Unquestionably, there are labor saving devices which can do mechanically the tasks that human minds and hands take much longer to do. When the acquisition and maintenance costs are weighed against the potential payroll and employee benefits savings, sound decisions can be reached. The total costs of printed forms are an element in most clerical operations which require consideration. Each form made obsolete by a change is an added expense to the new installation. Replacement forms meeting the specifications to today's equipment may result in much higher operating costs than first envisioned.

Analysis of payroll costs and potential payroll savings requires that the same principles of motion economy be observed in the office as in the plant. Projected savings from new installations frequently credit to new equipment the savings which are a result of better work habits that could have materialized without any equipment expenditure. Most of the elements of good form design are based upon an analysis of the work of the operator, the transcriber, the reader or the file clerk, to shave off the precious fractional seconds which mount up so fast under the volume of big business. Good layout, too, is based upon the analysis of operations in line with motion study principles to shave down distances which represents time which represents cost.

No ever-ready formula for analysis can

continued

be provided. However, an approach to such analysis might be made by separating the area of study into elements of (1) organization, (2) layout, (3) physical operations, (4) forms and (5) equipment. To each of these aspects, we may apply the questions of "Why?" "Where?" "When?" "Who?" and "How?"

Norman Barish ([3]) has suggested twenty-four principles of good systems, which might be applied to the present procedure for analysis or to the proposed procedure as a test. These principles, upon analysis, can be classified into the realms of (1) organization, (2) layout, (3) personnel, (4) operations and (5) cost. The relative importance of each of these elements to the *good* procedure may be discerned by the number of principles in each classification, which (including four principles dually classified) is as follows:

Organization	(13)
Layout	(2)
Personnel	(2)
Operations	(7)
Cost	(4)
Total	(28)

Application of these principles to the survey data world consititute an effective analysis.

A valid but simply analysis of a system would consist of the application of the following yardsticks:

1. *Simplicity*
2. *Operability*
3. *Understandability*
4. *Acceptability*
5. *Timeliness*

These yardsticks might well be used at each stage of the operation both as a test and as a guide.

Synthesis

Synthesis is the building or construction of a new or improved procedure from its smallest components. The process of synthesis or building up a new procedure or system is a continuous process of making step-by-step decisions. With a definite objective in mind, each of the possible methods of performing a task at each stage of the processing must be considered and a choice made.

It has been suggested that this process might well be reversed. The ideal end-result may first be established and then, proceeding backwards, the system outlined to produce that result.

Necessarily, such a process envisions a broad knowledge of systems applications, of equipment and adaptations of equipment, of forms and forms construction, of the survey data, and of the costs and relative costs of all the elements involved. Fortunately, this phase of the systems job is generally a pooled operation, where many minds may work together to eliminate the impracticable and to concentrate on the more practicable equipment and methods. Sales representatives and sales engineers perform their best services at this stage.

However, with due consideration to the recommendations of manufacturers or distributors, to the testimonials of others who have faced the same problems and arrived at some answer, to the likes and dislikes of Company personnel who insist on two fingers in the poi, and to the counsel and opinion of superiors and associates, the systems engineer must make a composite decision and arrive at a specific answer. It is conceivable, however, that no clear cut decision can be made. In such an instance, alternative routes may be selected and alternative answers may be submitted for final decision, with a listing of the alternatives in policy or operations which prevent an immediate solution.

As is frequently the case, we do not always have ideal conditions to make a choice. We are influenced by standards, by present equipment, by availability of servicing facilities, by qualifications of present

personnel and by numerous other factors which, though they may not influence our ultimate conclusions, will certainly influence the adaptation of those conclusions to the particular task in hand.

One of the most difficult decisions to make involving a new procedure is the weighing of the expedient against the ideal condition. Frequently, one is forced to establish a temporary procedure to establish needed improvements and to delay a permanent arrangement of more far reaching consequence until equipment may be procured, obstacles may be removed or circumvented, or changes can be established in related operations. Such problems often resolve themselves into weighing the value of an immediate improvement against the delay such an expedient will effect in the final overall program.

The opposing viewpoints of functionalization as against standardization arise in any study of magnitude. Each viewpoint has merit, but the merits to each viewpoint must be applied to the particular task in hand and to the particular application where the question arises. Similarly, the questions of centralization versus decentralization, leasing versus buying, self-operation versus service-bureau handling, etc., frequently become an issue. These are merely additional factors to be considered in arriving at overall decisions.

Selling

Improved systems are generally not self-evident. They do require selling. Whereas a trained systems man may observe what he considers an obvious answer, the salient advantages of the proposal must be pointed out to the person not trained in systems. Were these advantages self-evident, recourse to the systems man would not have been required in the first place.

The systems man has a selling job based upon the authority of knowledge and the authority or respect. The greater his knowledge and the higher the respect in which he is held, the simpler is his task of putting his ideas into operation.

The best way to sell a new system is to be enthusiastically sold yourself. The next step is a convincing sales presentation.

The customary sales technique in the field of systems is the survey report. Generally outlining the objectives and the scope of the investigation and containing data on both the present and proposed systems, the survey report is a compilation of data upon which management can act. The elaborateness, the volume of data, and the extent of charts and illustrated material will, of course, vary with the expenditure involved or the savings to be realized. This is more than a reporting device, however, it is a sales brochure.

Flow charts of the old and new systems, one superimposed upon the other, will provide an effective sales device. Certainly, they will point out any steps eliminated and the shortening of any lines of communication.

The use of a flow chart comprised of sample forms has also proved to be an effective sales device. Separate charts comprising both the old and the new procedures are set up on poster-board or wallboard in the affected operating department. The comparison of the old and the new graphically and effectively points out the advantages to be gained from the revised system.

One must recognize, however, that a new system must be sold not only to top management but also to the people who perform the task. In each instance, a different sales approach is required.

Human beings are not creatures of logic; they are creatures of emotion. They have basic needs for self preservation and self esteem. They resist new ideas which may appear to weaken their positions or to reflect upon their abilities as administrators. They resist change, *per se*, sometimes un-

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consciously, because the change represents infringement upon their own little forts wherein they can feel safe from outside intrusion and maintain undisputed authority.

Recognizing these emotional traits in people, we must recognize, understand and utilize the emotional appeals necessary to overcome emotional sales resistance. To get people to act, we must appeal to their needs. To a department that has difficulty in obtaining or holding adequately trained personnel, we will sell our systems on the basis of a reduced need for personnel. To a department that has suffered from a lack of adequate or timely information, we will sell our system on the speed with which all pertinent information can be provided.

Probably tied in with man's desire for prestige is the element of "self-identification." It is one of the biggest elements in selling. If people have a personal interest in a product or idea or policy or method by having contributed something to it, they can be sold much more readily on the finished result. Moreover, the greater their contribution to the end result, the greater is their desire for acceptance. Thus, an individual who is sold on the objective of a study; allowed to take part in the study by his contributions of information, suggestions and opinions; and permitted a word in the final decisions will offer only a minimum of resistance to the study results.

The teamwork of the "self-identification" technique has other advantages. It teaches the systems people to view the operation from the other man's viewpoint. If you place yourself in the other man's shoes, you may be able to detect in the course of your survey situations or problems which require clarifications, provisions or solutions but which might otherwise have been overlooked. In the selling job, you will have familiarized yourself with the possible objections and provided yourself with answers necessary to dissipate resistance. **s/p/a**

S&P Book Review

Automatic Computers: A Systems Approach for Business, *by Ned Chapin; D. Van Nostrand Company, Inc., Princeton, New Jersey, 525 pp., $8.75.*

► It is through books such as *Automatic Computers* that the mystery surrounding electronics and computers in business is gradually being dissipated. Mr. Chapin has presented the language and terms of business systems involving computers in a manner that can be understood easily by the uninitiated.

The seventeen chapters cover the general areas of computers such as the Input, Output, Operation, Fundamentals, Cost, etc. In addition, there are chapters on the Storage Unit and Programming. Each chapter concludes with some suggested reading material. Also some chapters have suggestions for further work. This tends to make the book adaptable as a text on Automation and Computers in business.

Almost 100 of the 525 pages are devoted to the appendix, which includes an extensive list of commercially available automatic computers and detailed information about each. This is particularly useful in a feasibility study. The appendix concludes with a glossary of computer terms and their definitions.

Automatic Computers is relatively easy to read and comprehend. Anyone with a mild introduction to business systems and data processing equipment would be able to understand it. The book is illustrated with charts and photographs.

by Louis C. Doyle

Capital Expenditure Planning And Forecasting

► The use of the stockholder's investment to expand or improve plant and equipment requires the most important of management decisions. Businesses rise and fall on the quality and timeliness of capital expenditure decisions. Mr. Russell B. Read, Planning Director, Westinghouse Electric, emphasizes this point when he says, "Capital investment decisions are fundamental to the future prosperity and stability of the enterprise. Capital investments carry with them advantages or handicaps which will be locked in for years to come—often beyond the span of any one management. They involve more uncertainty and require a longer and better forecasting judgment than probably any other aspect of business management". Then why shouldn't the very best planning and forecasting go into making these decisions?

Most of today's large and medium sized business concerns maintain a staff of planners and forecasters. Generally speaking, the more competitive the business or industry, the more elaborate is the planning and forecasting function. Even in the small company, planning and forecasting are a function of the chief financial officer. There are some big companies in stable industries, which by reason of their conservatism have no formal planning and forecasting pro-

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continued

gram. It may be pointed out that such companies have shown little or no growth pattern over the years. It follows then, that financial forecasting and capital investment and facility planning are factors leading business away from stagnation toward growth.

Capital budgets provide management with answers to these three questions:

(1) *What are the total capital funds the company will need during the coming year?*

(2) *When during the year will these funds be spent?*

(3) *How will these funds be spent?*

There is a "by-product" advantage to capital budgeting or forecasting. It compels operating personnel to plan ahead. It helps assure the stockholders of efficient equipment and a modern plant, and reduces chances that profitable opportunities will be missed.

One important thing that all businesses have in common is the fact that there are always more demands for capital outlays than there is capital available. With half a dozen situations vying for a business' capital expenditure dollar, the financial executive is placed in a position where he must classify and evaluate proposals so that arithmetic methods rather than partisanship dictates the best choice.

Looking at the advantages of capital expenditure forecasting from the other end of the line, management gets an assist in projecting its cash needs. Where outside financing may be required, cash projections facilitate the borrowing or subscribing of funds.

There has been criticism levelled at capital expenditure forecasting. Some business executives claim that it is inflexible, unrealistic, and extravagant. In reports to the National Industrial Conference Board by 361 contributing companies, many reported that their executives forecasted too ambitious a capital expenditure program year after year. Many companies complained that there was little resemblance between the program undertaken and the one mapped out in the original forecast. One manufacturer of tobacco products said, "Our principal objection to a capital expenditure budget is that it is too much of an invitation to look for projects on which to spend a fixed appropriation".

This type of criticism may be condemnation of that particular company's forecasting and project evaluation procedure, but it should not be aimed at capital expenditure forecasting as a control technique. The consensus of most companies today is that well managed plans and forecasts will screen out the extravagant projects and defer those of lesser importance to a more opportune time.

Most business concerns devoting attention to capital expenditure forecasting extend their planning to three or five years. The first year is a firm projection and the subsequent years are tentative and subject to further review. The year-at-hand forecast details all projects, large and small. Project details for the years beyond the first are generally limited by dollar amount. This allows greater attention to the first year's expenditures and to the analysis of the most important expenditures of the future years. There are a few instances where over-all totals for various classes of expenditures are regarded as sufficient detail for the years beyond the first.

There seems to be two general methods employed in preparing the capital budget. The most widely used system has the forecast originate with the people primarily interested in and closest to the proposed improvements. These departmental estimates are analyzed and reviewed by top management. Finally, they are screened and translated into an over-all estimate of capital needs.

A second method is used in smaller companies where management has an intimate

knowledge of the company's capital needs. It involves, first of all, deciding what the total expenditure will be. Then these funds are allocated throughout the organization. One company policy reads as follows: "A budget will be assigned annually to each location and local management will decide who gets it and how much—in conformance, of course, to general policy".

A shipbuilding company with approximately 2,000 employees reports: "In a business this size it is possible for the president and other top management men to be generally familiar with capital expenditure requirements without relying to a great extent on the judgment of subordinates. The president prepares the budget in consultation with the yard manager and plant engineer".

Another rather unique method is used by the Dennison Mfg. Co. Their system does not involve the projecting of capital needs in terms of specific projects. Instead they set facility expenditure standards based on the historical relationship of sales to asset life. Working capital projections are made based on historical relationships. With sales and cash budgets established five years ahead they project their capital expenditures based on ratios which were built on past performance.

The important thing in any business, regardless of the general forecasting method used, is the selection and control of capital investments. The problem of selectivity baffles many executives and calls out a wide range of solutions. Most important is the need for a systematic method of organizing, classifying, evaluating and authorizing capital expenditure projects.

Investment opportunities, more numerous than the capital available to undertake them, come to light through:

(1) Reviews of the economic effectiveness of existing facilities.
(2) Industrial engineering studies of the technology of an operation.
(3) Comparisons with competitive methods and facilities.
(4) Contacts with vendors of alternative resources.
(5) Creative thinking of the organization.
(6) Organized product research.
(7) Market research demanding expansion.

These opportunities will then be translated into projects, and the projects will, in turn, be classified in terms of their objective. The usual classification follows this pattern:

(1) Replacement investments intended to reduce costs of operating present equipment.
(2) Expansion investments involving the providing of greater capacity for the present product line or the production of new items.
(3) Product investments intended to improve quality or design.
(4) Necessity investments required by law, or due to health or safety factors, or employee relations.

The next step is rating each of the projects that fall within each of the classifications. Such ratings in a multi-plant, multi-division organization must be very sharply defined. There are three broad aspects to the rating process. Project requests are analyzed in terms of:

(1) Relation to the company's over-all operations including its long range plans.
(2) Merit of the individual project.
(3) Available resources of the company.

The two most popular methods of evaluating and ranking specific projects are:

(1) Rate of Return on Investment
(2) Pay-out (or pay-back) period

Economic justification of all projects is required except for certain necessity investments, e.g., smoke abatement equipment to comply with local air pollution ordinances. One method would be used exclusively

PROPOSED FACILITIES EXPENDITURE

PRELIMINARY JUSTIFICATION

(IN THOUSANDS OF DOLLARS)

PLANT _____ DIVISION _____ DATE _____ PROGRAM REF. NO. _____

PROPOSAL DESCRIPTION

CAPACITY DATA (UNIT)	19	19	19	19	19
STANDARD VOLUME (___ HRS/DAY ___ DAYS/YEAR)					
FACILITIES PLANNING VOLUME (___ HRS/DAY ___ DAYS/YEAR)					
PRESENT CAPACITY (___ HRS/DAY ___ DAYS/YEAR)					
PROPOSED CAPACITY (___ HRS/DAY ___ DAYS/YEAR)					

	TOTAL	19	19	19
FUND REQUIREMENTS:				
REAL ESTATE AND BUILDINGS				
MACHINERY AND EQUIPMENT				
FURNITURE AND FIXTURES				
TOTAL CAPITAL				
EXPENSE				
TOTAL PROPOSAL				
ADDITIONAL WORKING FUNDS:				
CASH AND RECEIVABLES				
INVENTORIES				
PERMANENT TOOLS				
TOTAL FUND REQUIREMENTS				

REVENUE AND OPERATING COST CHANGES INCREASE/ (DECREASE)	19	19	19	NORMAL
REVENUE				
OPERATING COST:				
MATERIAL, LABOR AND BURDEN				
OUTBOUND TRANSPORTATION				
TOOL AMORTIZATION				
STARTING COST				
DIRECT AND PRORATED EXPENSE				
TOTAL COST				
OPERATING MARGIN - BEFORE TAX				
- AFTER TAX				
DEPRECIATION				
OPERATING MARGIN BEFORE DEPRECIATION				

RETIREMENTS AND DISPOSALS				
ORIGINAL COST	DEPRECIATION TAKEN	NET BOOK VALUE	EST. DISPOSAL VALUE	PROFIT OR (LOSS)

NORMAL RETURN ON AVERAGE ASSETS EMPLOYED		PAYOUT PERIOD
BEFORE TAX	AFTER % TAX	AFTER TAX
%	%	YRS.

OTHER JUSTIFICATION (ATTACH SUPPLEMENTAL JUSTIFICATION OF ALTERNATIVES)

within a company in order that projects can be compared and ranked on the same basis. Some companies use both methods on every project for a double evaluation.

The rate of return on investment method has probably as many variations as there are companies using it. Basically, it relates the cost savings of the investment to the capital outlay. Usually the annual cost savings is converted to present value by discounting for the time value of money. Minimum acceptable rates of return vary with the industry and the individual company, but the average probably falls around 20% per year.

The pay-out method measures the cost savings of a project with the investment cost in terms of the length of time to recover the capital expenditure. Here again, the maximum acceptable pay-out period would depend on the individual company and the useful life of the equipment or facility. Using this method, if the pay-out period is determined to be four years, the decision as to the amount of useful life in the equipment beyond the fourth year is a big one. Generally, the longer the pay-out periods on investments, the more limited is the use of the pay-out method of evaluation.

The auto industry is prone to use the pay-out method since rapid replenishment of working capital is vital. Also, with the rapid rate of technological changes, short pay-out periods are necessary to screen out obsolescence.

Two other evaluation techniques are worthy of mention at this time. The MAPI formula (Machinery and Allied Products Institute) establishes a basis for determining the influence of obsolescence on the rate of return on investment. Under the formula, new equipment is called the challenger, while old equipment is the defender. Through a series of calculations, the economics of investing in new equipment or retaining the old becomes evident. Many companies use this formula in conjunction with their capital expenditure budgeting. Cooper-Bessemer, manufacturers of compressors and diesel engines, reports to the NICB in detail on their use of the MSPI formula.

A second evaluation method, Profitability Index, is outlined by Mr. Ray I. Reul in the July-August 1957, *Harvard Business Review*. The basis for this system is an identification and segregation of investment proposals into those classified as "profit maintaining" and "profit adding".

Profit Maintaining

1. Replacement of existing facilities which will no longer function.
2. Improvement of existing facilities to circumvent competition.
3. Provision for new facilities which were accidentally or intentionally omitted when original facilities were installed but which now become essential to the continuation of the existing facilities.

Profit Adding

1. Provision for new facilities to increase profit by providing new business or by expanding existing operations.
2. Provision for facilities that will improve product quality and permit higher prices and profit margins.
3. Provision for facilities that will reduce the cost of the product and result in increased profit through larger profit margins or increased sales volume.

The profitability index measures the soundness of an investment on the principle of "cash flow back", taking into account the time value of money and the consistency of the plan for the return of the original investment. Mr. Reul indicates that, "there are some things the profitability index cannot do. It cannot substitute for judgment."

Note Exhibit A, a typical facilities expenditure preliminary justification form where both return on assets employed and

continued

pay-out period is computed. Exhibit B is a summary sheet used for all capital expenditure projects at the final review stage.

After the projects have been evaluated, the next step is the weeding out. As we indicated earlier, the supply of available capital rarely covers the demands that can be made upon it. It should be indicated at this point that the "capital available" figure is carefully arrived at and rather inflexible. It is a result of closely planned net earnings, depreciation charges, and dividend requirements. As Westinghouse's R. B. Read relates, "The fun comes when the irresistible force represented by the cash demand meets the immovable object represented by the cash supply". Management is not likely to earmark all funds for specific projects. Generally five or ten per cent will be set aside for emergency projects.

Capital Budget

The cream of the capital expenditure crop reaches the final capital budget. Inclusion as a capital budget item does not give automatic authorization to expend money. However, it usually does allow internal plans to expand and develop the project. Authorization of a project not included in the capital budget, would have to be of momentous importance and would often be referred to as a "crash program". The authorization of such an item generally requires that one of two things happen:

(1) Substitution for and therefore deferment of an item originally approved in the Capital budget.

(2) Additional cash financing.

The authorization to begin expenditure of funds on a project is a separate procedure in itself. In a multi-plant, multi-division organization the review process for individual projects is lengthy. Let's see how this might take place for a typical decentralized company. From the originator at the plant level the project usually passes to plant comptroller, plant industrial engineer, plant process engineer and plant manager. Any of these individuals has the opportunity to turn the project back for further analysis or rework. The plant manager will sign approval that the project is financially justified and strategically sound.

The project passes to the Division level where the comptroller, engineering and manufacturing staffs perform their reviews. At this point project details are analyzed, and, in some cases, sent back to the plants for revision. Final approval is granted by the Division General Manager.

There is generally a dollar limitation placed on the scope of the review process. For example, projects less than $25,000 may require only plant and division authorization, as long as they are included in the capital budget. Authorizations over $25,000 may require corporate approval.

Once authorization is received and the money appropriated, controls are tightened. The timing and amount of each expenditure is watched closely. As the amount expended approaches 75% to 80% of the total appropriation, a careful audit is usually initiated to make certain that the project will not run over either in dollars or days.

The close out of a project is usually made definite so that "under spent" projects are not loaded with non-essentials. Projects requiring additional appropriations, generally must go back through the complete review process.

A report of actual expenditures versus the capital budget will reveal shortcomings and should tend to sharpen the budgeting process. The real test of capital budgeting however, comes when operating results are compared with the pay-out period and return on investment projected in the budget.

One of the by-product advantages of capital expenditure planning is neglected in most writings on this subject. Every company large and small can afford to carry out a capital expenditure planning

FINANCIAL ANALYSIS SUMMARY

(CENTS OMITTED)

DIVISION OR UNIT	DATE	REQUEST NO.
PLANT	DEPARTMENT	SUPPLEMENT NO.
PROJECT TITLE		

CAPACITY DATA (UNIT)	MODEL YEAR 19	19	19	NORMAL RETURN
STANDARD VOLUME (___ HRS/DAY ___ DAYS/YEAR)				
FACILITIES PLANNING VOL. (___ HRS/DAY ___ DAYS/YEAR)				
PRESENT CAPACITY (___ HRS/DAY ___ DAYS/YEAR)				
PROPOSED CAPACITY (___ HRS/DAY ___ DAYS/YEAR)				
REVENUE AND OPERATING COST CHANGES INCREASE/ (DECREASE)				
REVENUE				
OPERATING COST:				
MATERIAL, LABOR AND BURDEN				
OUTBOUND TRANSPORTATION				
TOOL AMORTIZATION				
STARTING COST				
DIRECT AND PRORATED EXPENSE				
OTHER INCOME AND DEDUCTIONS (NET)				
TOTAL COST				
OPERATING MARGIN - - - BEFORE TAXES				
OPERATING MARGIN - - - AFTER TAXES				

INVESTMENT	INITIAL AMOUNT	AVERAGE NET INVESTMENT			
LAND					
BUILDINGS AND IMPROVEMENTS					
MACHINERY AND EQUIPMENT					
FURNITURE AND FIXTURES					
TOTAL FIXED ASSETS					
EXPENSE		XXXX	XXXX	XXXX	XXXX
TOTAL PROJECT					
OTHER:					
CASH AND RECEIVABLES					
INVENTORIES					
PERMANENT TOOLS					
TOTAL ASSETS EMPLOYED					
ANNUAL RETURN ON ASSETS EMPLOYED					
BEFORE TAXES		%	%	%	%
AFTER TAXES		%	%	%	%
PAYOUT PERIOD AFTER TAXES					
DEPRECIATION					
OPERATING MARGIN BEFORE DEPRECIATION					
PAYOUT PERIOD ___ YEARS ___ MONTHS					

SIGNATURES

PLANT	DATE	CORPORATION	DATE
DIVISION	DATE		

Exhibit B

continued

program at the lowest supervisory level. Some companies do this with a "Cost reduction" program which works along these lines:

(1) Each manufacturing location is required to prepare a projection, monthly, of the savings that could be realized with a change in equipment or process. This serves as a kind of supervisors "suggestion program".

(2) All supervisors and foremen prepare their reports in detail—material, labor, and burden to be saved in their own operational area.

(3) Plant management reviews the prospects of such cost savings ideas and forms the nucleus for capital expenditure proposals.

(4) Progress reports prepared by plant management keep supervisory employees advised of action taken and serve to stimulate creative thinking.

Whether or not a company has a formal capital expenditure forecasting system, it should use the cost reduction program to sound out the ideas of its supervisors and to create a broader functioning management team.

We have already emphasized the importance of good capital expenditure planning. Once we have a strong planning organization and sound planning procedures we should turn our attention to an often overlooked source of capital expenditure cost reduction. In the past, capital expenditures have been concentrated on the lowering of the direct labor content of our product costs. We have automated our production lines but we have neglected our overhead costs. More than one half of the cost of a manufactured product is buried in sales, distribution, and clerical operations. State and local taxes are an increasingly important cost problem. We predict that the future will find capital expenditures increasing in the direction of overhead cost reduction. **s/p/a**

by Leslie Matthies

"Let's Get the

SOME YEARS AGO I HEARD A NUMBER OF engineers who were working on a design keep emphasizing the words, "Let's get the job done and to hell with the paper."

This certainly sounds good. It sounds as though somebody is really getting at the real work, getting right at the heart of things and pushing aside all the useless red tape.

Well, the boys got the job done alright, but they almost broke the company in the doing. Only an RFC loan enabled the company to survive.

This sounds quite contrary to what you expect. You naturally would say those "let's-get-the-job-done" boys are right. We have too much fooling around with paper and things of that sort.

There is an old argument that in many places there is too much paper, far more than necessary and much of it completely useless. There is certainly truth in this contention. But the use of paper has been overdone because the *use of paper hasn't been thought out and analyzed.*

People vaguely sense that they are using paper for tools, but they are so busy getting the job done that they don't have time to consider if they are using the right paper tool or if they are using the tool correctly.

Back to our story. The engineers who got the job done in the company were "pushing the state-of-the-art." They were knocking at the outer perimeter of the present ball of knowledge. So the engineering was not at all complete on the draft-

e Job Done!"

ing board. Much of the engineering had to be done as the first article itself was developed. It took barrels of dollars to complete the engineering on this first "prototype." So finally they had one article and it worked. The boys who said, "Let's get the job done", *did get the job done.* But they had a dangerous blind spot in their vision. They focused completely on the article. Changes to the article itself were never reflected in the paper. After all, hadn't they said "to hell with the paper?"

This is hard to believe, but when the engineering information was released to the production shops, the paper that was released in no way reflected the successful article—insofar as all the trouble spots that had been encountered were concerned. The original contours were there, yes, but the vital changes were not recorded.

It's hard to explain, yet it did happen. Intelligent technical men made this basic error.

Despite the barrels of money that had to be spent by the engineers working on the first article—when the drawings were released to the production shops, the shop people had to do the job all over again—agony by agony, step by step, production men had to build another first article. Costs? Double, of course, and more. Production lines rarely are set up right to do experimental work.

But the end wasn't yet. As the production people discovered that the drawings and technical procedures they received would not guide them to build an article that could pass the tests, they had to write up thousands of engineering change requests. These flooded back into the engineering department. So, all the paper work that the "let's-get-the-job-done" boys had tried to avoid came right back into their laps.

A first article is just a first article. We built it once so we know we can do it again. So now we have the first article and there it sits out on the floor and it works. But we didn't intend to build only one article; we intended to build 50, or 500, or 5,000.

During the fiasco we have been describing, men forgot this simple but basic principle—you must control data. The engineers were making sketches on the backs of envelopes, often making no sketches at all, sometimes standing over the shoulder of the mechanic and directing his operations. This is all fine, if all we want is the first article. But in our discussion here, the first article is only a proof. If the engineer doesn't also produce a *good* record of what he did in securing that first *good* article, has he really got the job done?

As we see it, any work that is done on an experimental engineering basis has two objectives:

1. To make a good first article.
2. To make a record of how that first article was made so we can make more.

That is all there is to it.

Consider the brewery that finally settled on "Brew 102" as the best. If records had not been kept on each of the brews, and let's assume they made hundreds of brews, how could they go back and use "Brew 102" on a production basis if the formula that made that particular "first article" is lost?

s/p/a

An editorial

A Taste for Paper

► ONE OF OUR EDITORIAL PASTIMES IS BROWSING THROUGH OUR OWN five-foot bookshelf of old systems publications, looking for background material on subjects of current interest. This pursuit has some interesting results, as when we sometimes turn up a half-forgotten article which in some respects exceeds today's advanced thinking on a particular topic. These occasions are admittedly rare.

A more frequent occurrence is when we come across a bit of buried treasure such as a well-written statement of systems principles or a classic definition of a basic concept —or an amusing treatment of a familiar problem. We stumbled across a good example of the last when we were recently thumbing through our copy of the 1956 edition of *Workshop for Management*. It is John Dethman's caricature of the "papyrophile" or paper-lover, in his article on records management. Much of it is worth quoting.

"The human affinity for paper is a mysterious thing," writes Dethman. "People like paper. They collect it, treasure it, and measure their importance by how much they receive and send. They hoard it as the stamp collector hoards stamps, and they revel in it like a puppy rolling in a drift of autumn leaves."

The author divides these paper-lovers into three species. First there is the lover of other people's paper—this is the fellow who gets his name on all mailing lists, internal and external, and makes certain that every piece of paper he can gather is carefully filed away—permanently or longer.

Next is the lover of his fellow man. This love expresses itself in the generation of numerous needless letters and memos, with the names of the humble and forgotten on the long carbon copy or cc list.

Finally there is the lover of his own paper. This last species will have in his files the first memo he ever wrote, his first, second, third and fourth drafts of every project he ever worked on—and the final drafts too.

"He never refers to these things," declares Dethman, "But if you observe him going into his office when he thinks you aren't watching, you will see him bestow a loving pat on his battery of file cabinets."

After reading this we checked into our own files. We're glad we didn't find that first memo we ever wrote, but we did spend a busy half-hour throwing out some of those first, second and third drafts. Filled up quite a few waste baskets, too. Made us think of George Derry's remarks, in the 1958 *Ideas for Management*, about the man who keeps all of his old gas bills—because that was the easiest decision to make.

That human affinity for paper is a mysterious thing. Does anyone need a mirror? **s/p/a**

THE EDITORS